

Non-Revenue Water Reduction

Module 10: *Leak Detection Equipment*

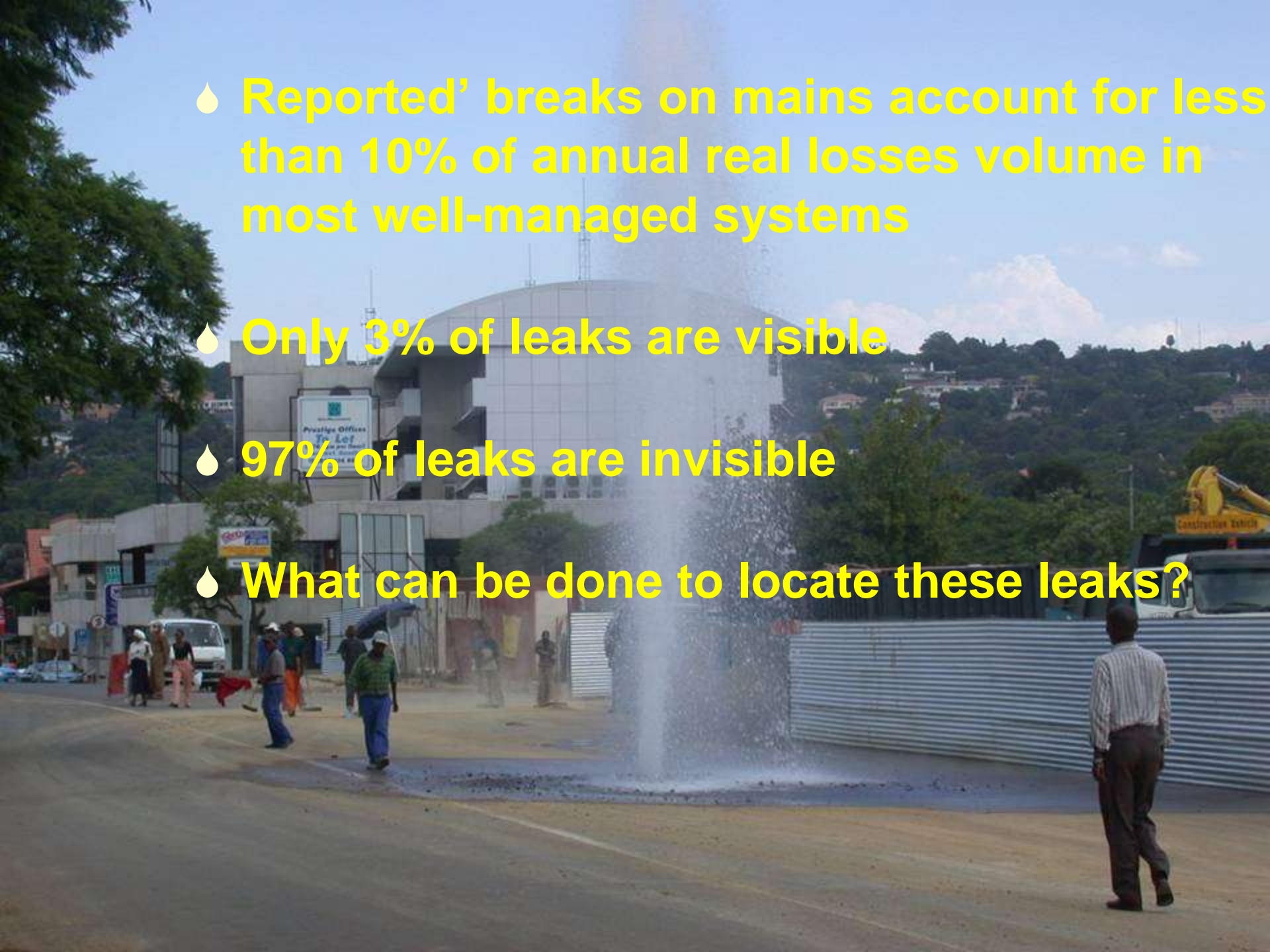
Version 1.0 04/xx/07

💧 **Reported' breaks on mains account for less than 10% of annual real losses volume in most well-managed systems**

💧 **Only 3% of leaks are visible**

💧 **97% of leaks are invisible**

💧 **What can be done to locate these leaks?**



If only leakage detection was this easy



Unfortunately it is not. We have to find the leak - they do not find us



Leakage operatives ? - NO



X-Ray vision ? - NO



Leakage operative ? - YES



- 💧 How does 'ALF' find leaks?
- 💧 His only chance is to detect leak noises
- 💧 He needs equipment, training and commitment!

Average Leak Finder – 'A.L.F. '

There are Many Causes of Noise in Water Pipelines

- 💧 Consumption
- 💧 Pressure reducing valve (PRV)
- 💧 Partial obstruction of pipe
- 💧 Partially closed valves
- 💧 Change in pipe diameter
- 💧 Pumps
- 💧 Electrical interference
- 💧 Gas Compressors
- 💧 **LEAKAGE**

Material Types

- 💧 Steel
- 💧 Iron
- 💧 Copper
- 💧 Asbestos Cement/Concrete
- 💧 Lead
- 💧 PVC
- 💧 Polyethylene

Good noise propagation



Poor noise propagation

Factor Affecting Acoustic Leak Detection

- 💧 Pipe material (Hard – Soft)
- 💧 Pipe diameter (80mm – 1000mm)
- 💧 Pressure (4m – 60m)
- 💧 Background noise (Obstructions – PRV's)
- 💧 Usage (Domestic – Industrial)
- 💧 Best time to do acoustic leak detection is when these are at a minimum and pressure is at the maximum

Leak Noise Quality

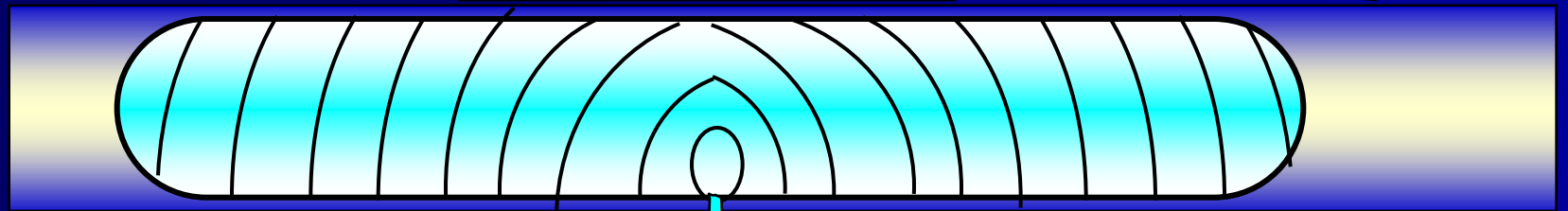
Good quality

Poor quality

High water pressure	Low water pressure
Hard backfill	Soft backfill
Small rupture	Split mains
Clean pipes	Encrusted pipes
Metallic pipes	Non metallic pipes
Small diameter	Large diameter

Any or all these for good
leak location.

Acoustic noise transfer from a leak in a section of pipe

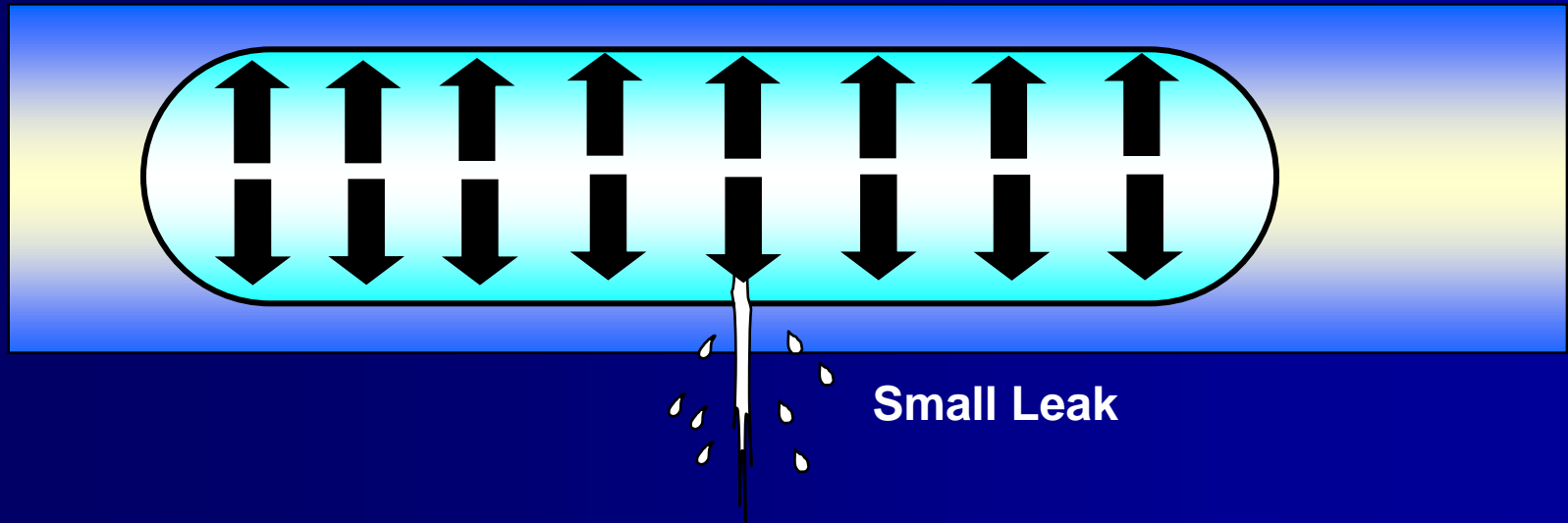


Energy generated from the leak is transmitted within the pipe through the water

energy from the leak is also transmitted through the pipe wall

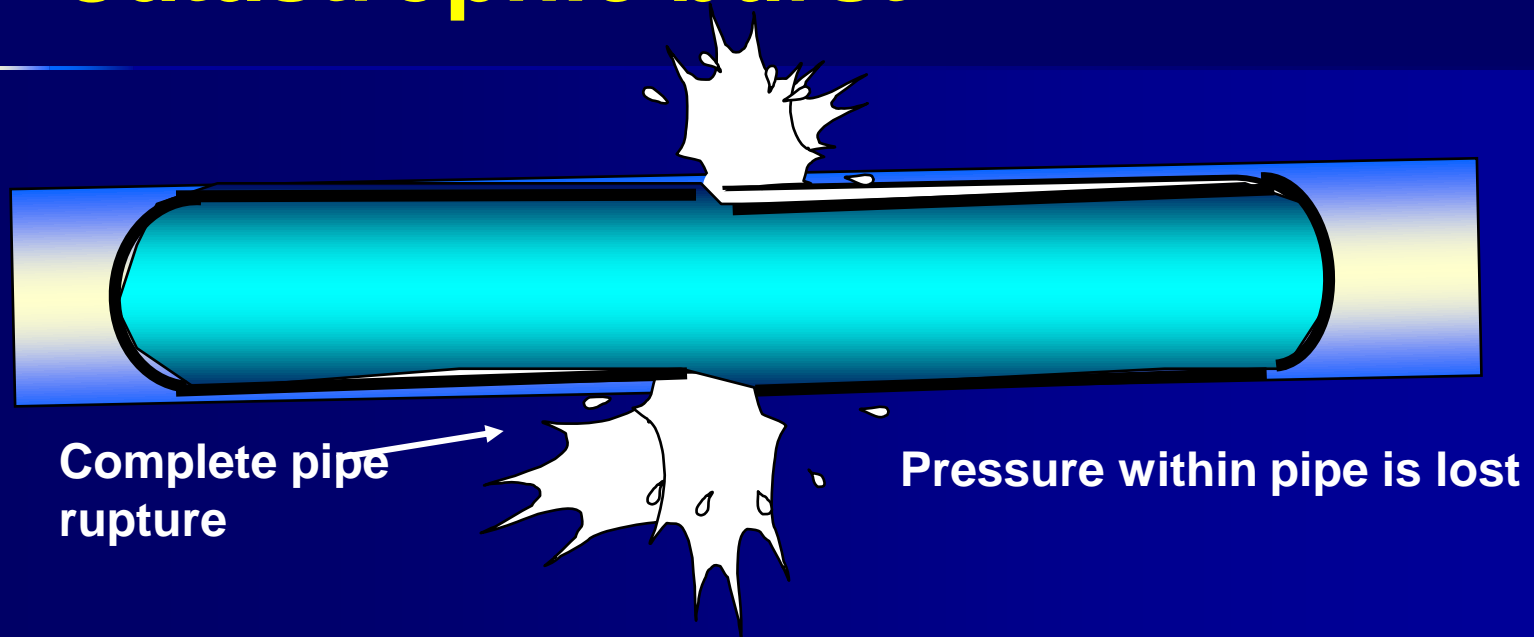
burst

Pressure and small leaks



Small Leak - Partial or no loss of pressure loss in the pipe , these leaks can run for long periods of time without being recognised

Catastrophic burst

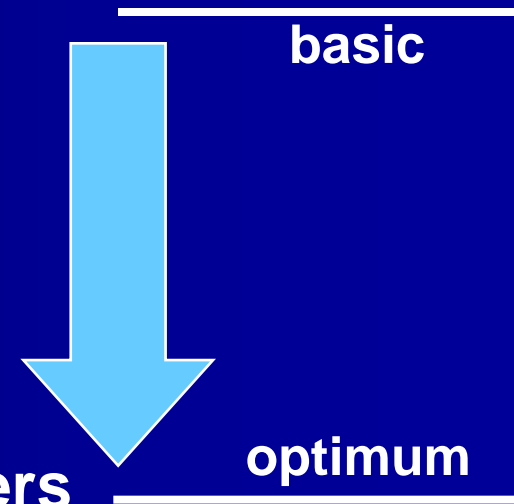


Large burst complete loss of pressure – these leaks can be immediately identified through loss of pressure but in cases difficult to locate

How do we do successful leakage detection (LLP)

💧 Localise

- Hydrant and main valves survey
- All fittings survey
- Step testing
- Noise loggers
- District Metered Areas (DMAs)
- DMAs combined with noise loggers



💧 Locate - Correlator

💧 Pinpoint - Listening device

Driving down Leakage

- Localise
- Locate
- Pinpoint

- Monitor

- Localise

- Locate

- Pinpoint

- Confirm

- Repair

- Localise
- Locate
- Pinpoint

Localising

💧 Noise logger

- very successful if used correctly, many successes world wide.

💧 Step testing

- Used throughout the world, may cause issues with water quality.

Sounding

- Localise
- Locate
- Pinpoint



💧 Mains fitting only

- Listen on main fittings only, sluice valve, fire hydrant.
- Quicker survey will miss small leaks but will locate larger leaks such as burst mains
- Appropriate only for metallic mains

💧 All fittings survey

- Listen on every fitting, stop tap, sluice valve, fire hydrant.
- Time consuming but ensures every leak is located including very small fitment leaks
- Appropriate for all mains material

- Localise
- Locate
- Pinpoint

Leak localising \$300-\$800+ per unit

- 💧 Listens to all noise not just leaks
- 💧 Long battery life
- 💧 Easy to install
- 💧 Programmable for intermittent supply
- 💧 Can be installed during the day
- 💧 Easy to interpret – flashing lights etc



- Localise
- Locate
- Pinpoint

Leak localising – Noise loggers

- 💧 Ideally deployed up to 250m apart on metallic mains but can be up to 750m.
- 💧 Deployed up to 80m apart on non metallic mains
- 💧 Basic loggers only record noise level and show which one is closest to the leak
- 💧 Advanced loggers can correlate between units when leak noise is identified



- Localise
- Locate
- Pinpoint

Leak localising – Noise loggers

- 💧 Attach to main fittings or service connections
- 💧 Listen for noise when the system is at its quietest - 2am – 4am
- 💧 Can be left permanently In situ or moved on a daily basis
- 💧 Downloaded to PC by radio link



Localise

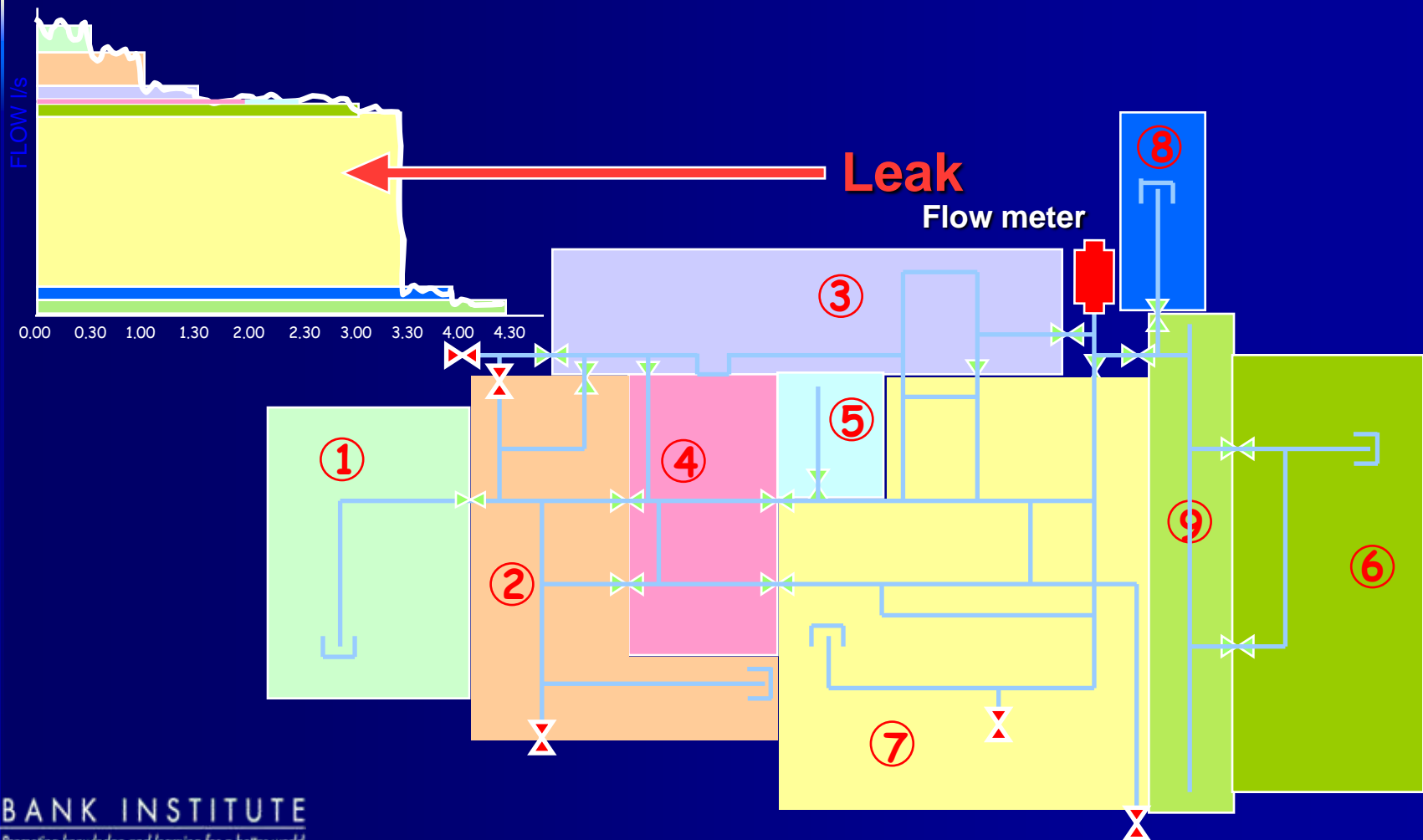
- Localise
- Locate
- Pinpoint

💧 Step testing

- Systematically isolate the network by shutting valves.
- Reduction in flow measured at the meter corresponds to the leak in the step.
- Used throughout the world with much success.
- Particularly effective when the knowledge of the network is poor
- May cause water quality problems.

Step Testing Principles

- Localise
- Locate
- Pinpoint



Driving down leakage

- Localise
- **Locate**
- Pinpoint

- Monitor
- Localise leak
- **Locate**
- Pinpoint
- Confirm
- Repair

- Localise
- **Locate**
- Pinpoint

Locating

💧 Correlator

- **Must be used as part of a strategy and best success when areas are targeted**

💧 Correlating Noise Logger

- **very successful if used correctly, many successes world wide.**

- Localise
- Locate
- Pinpoint

Correlation Formula

$$L = \frac{D - (V \times T_d)}{2}$$

L = Leak position (m) (meters)

V = Velocity of sound along pipe (m/ms) (meters per millisecond)

D = Length of pipe (m) (meters)

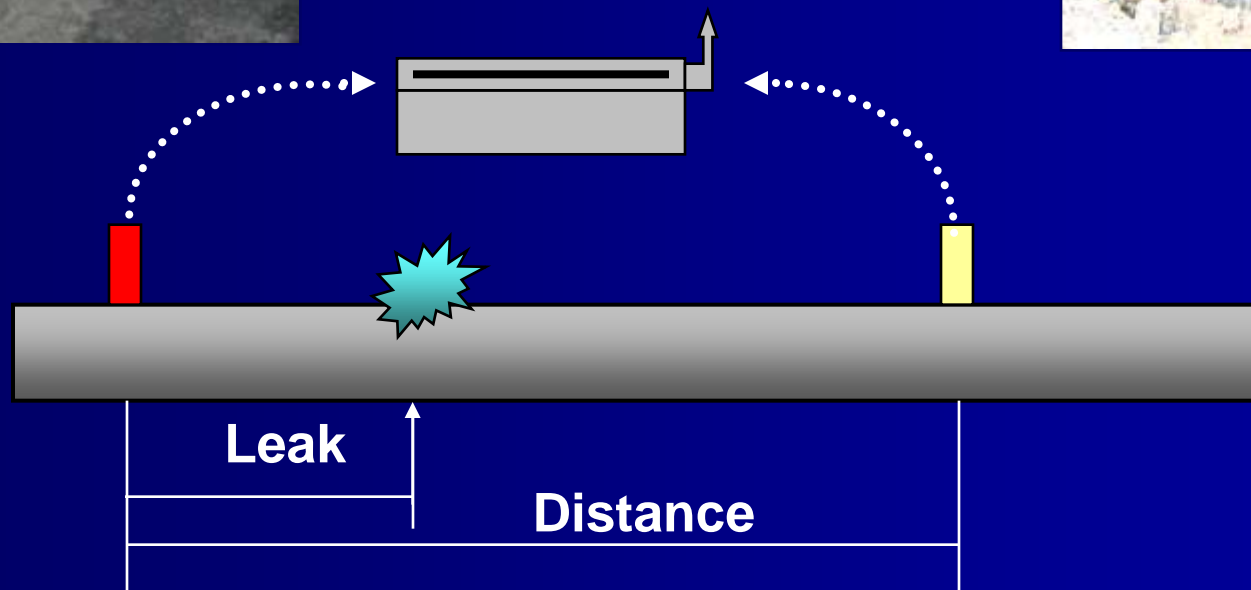
Td = time delay (ms) (milliseconds)

Correlating technique

- Localise
- Locate
- Pinpoint



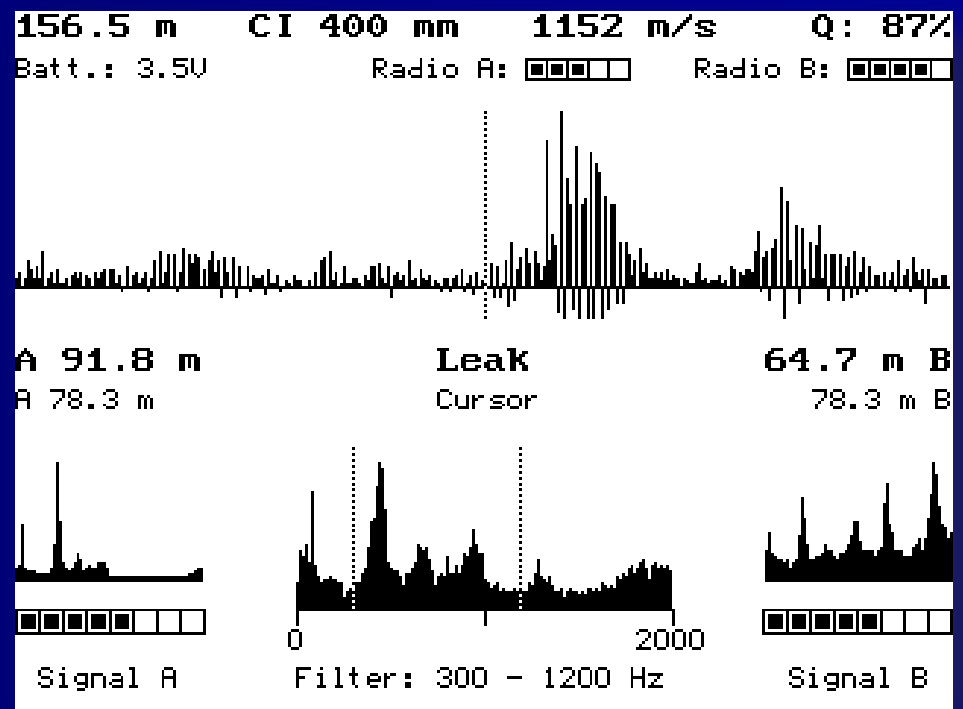
$$L = \frac{D - (V \times Td)}{2}$$



- Localise
- Locate
- Pinpoint

Example screen

- 💧 Leak position from either red or blue transmitter
- 💧 Total distance
- 💧 Sensor type used
- 💧 Time delay
- 💧 Velocity used
- 💧 Filter range used
- 💧 Battery level
- 💧 Date



- Localise
- Locate
- Pinpoint

Evolution of Correlators

Early correlators



Palm handheld multi-point digital LNC



- Localise
- Locate
- Pinpoint

The correlator processing unit

- 💧 Ultra high sensors
(extended low frequency response
for plastic pipes)
- 💧 Hi-fi sound quality
- 💧 Multi correlation capability
- 💧 FFT - Fast Fourier Transforms
- 💧 Assisted filter selection
- 💧 High speed data processing speed
- 💧 Save correlations for reporting



Noise sensor – Accelerometer

- Localise
- **Locate**
- Pinpoint

Transmitter types



Antenna

Water proof shroud

Radio Transmitter

Connection
to transmitter

Accelerometer
& Magnet



- Localise
- Locate
- Pinpoint

What correlator

Entry level - \$12,000+

- 💧 **Entry level**
 - Less complicated
 - Less functions
 - Easier to use
 - Single channel radio link - disadvantage when correlating long distance



What correlator

Mid-range level - \$20,000+

- Localise
- Locate
- Pinpoint

- 💧 Mid Range level
 - Easy to use
 - Has some advanced functions
 - Will find most leaks
 - Improved filtering
 - Dual radio channel



- Localise
- Locate
- Pinpoint

What correlator

Advanced level - \$30,000+

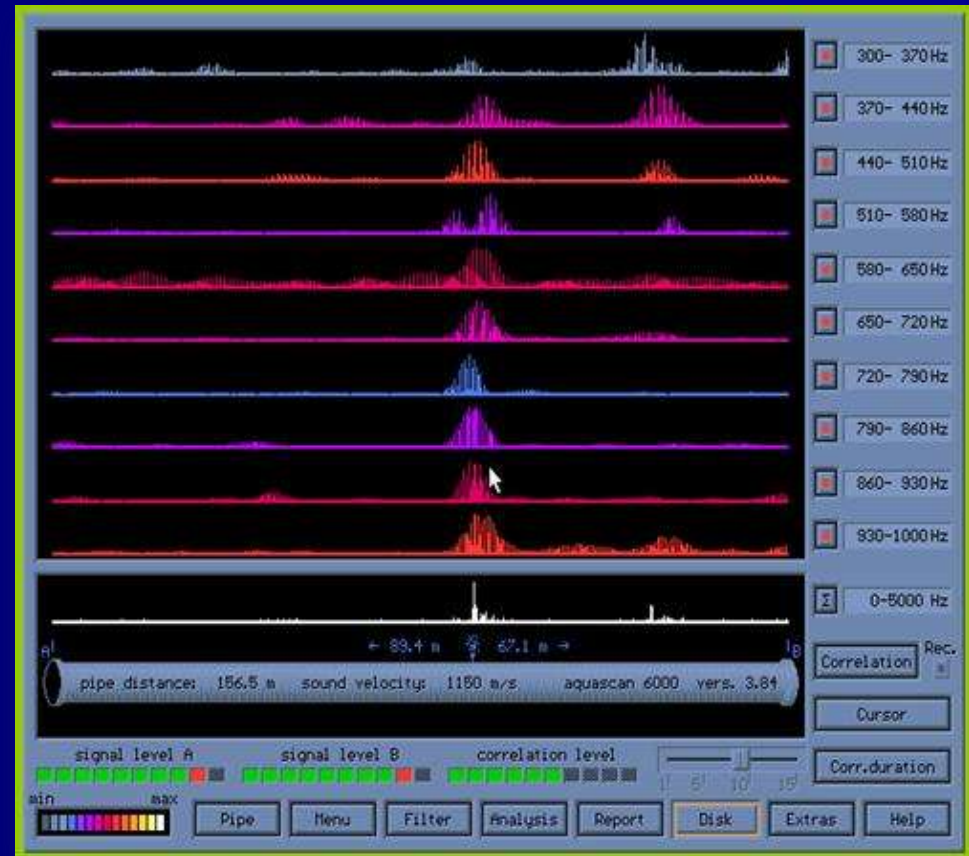
- 💧 Advanced level
 - Experienced technician
 - Advanced functions
 - Will find most difficult leaks
 - Tri correlation available
 - Processor or laptop versions available
 - Advanced processing



Advanced correlator - simultaneous multi correlation

- Localise
- Locate
- Pinpoint

- 💧 10 correlations being shown with different filter settings on one screen
- 💧 Should be used by skilled operator
- 💧 Very good when correlating on non metallic mains



- Localise
- **Locate**
- Pinpoint

Pipe measurement - basic errors

- 💧 Pipe location is required for accurate distance measurement
- 💧 If network plans are unreliable the pipe locator should be used where possible
- 💧 Don't forget pipe depth



- Localise
- Locate
- Pinpoint

Driving down leakage

- Monitor
- Localise leak
- Locate
- Pinpoint
- Confirm
- Repair

- Localise
- Locate
- Pinpoint

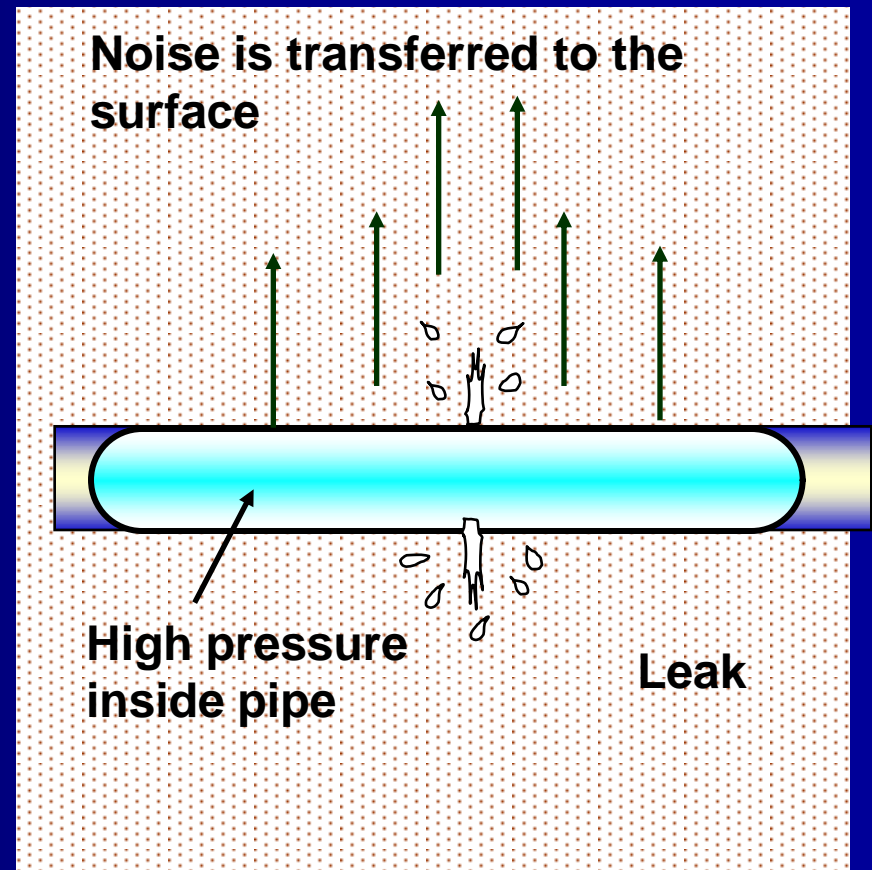
What is Pinpointing?

- 💧 Pinpointing means to confirm the exact location of a leak by listening on the surface
- 💧 Best done with ground microphone but can also be done with listening stick
- 💧 Confirmation of leak location is essential to ensure that excavation is accurately targeted

- Localise
- Locate
- Pinpoint

Noise transfer to the surface

- 💧 Depending on the backfill the noise transferral is different
- 💧 The pressure within the pipe will affect the quantity of water being lost and the noise generated by the leak
- 💧 The size of leak will affect the transfer of noise



Confirm Leak Position

- Localise
- Locate
- Pinpoint

- 💧 Conventional Listening Stick
- 💧 Electronic Listening Stick
- 💧 Ground Microphone



- Localise
- Locate
- Pinpoint

Listening sticks \$50-\$200

- 💧 Manual listening stick
- 💧 Relies on the technician and his ability to hear
- 💧 Various types available
- 💧 Made from a range of materials
- 💧 Has no visual display
- 💧 Can be used during a fittings survey or to pinpoint a leak position



Electronic listening stick

\$1,000 – \$6,000

- Localise
- Locate
- Pinpoint

- 💧 Easy to use
- 💧 Amplified sound
- 💧 Sound display available
- 💧 Headphone to prevent background noise
- 💧 Digital & analogue
- 💧 Used to noise map during an “all fittings survey”



Electronic ground microphones

\$2,000 – \$6,000

- Localise
- Locate
- Pinpoint

- 💧 Easy to use
- 💧 Amplified sound
- 💧 Sound display available
- 💧 Headphone to prevent background noise
- 💧 Digital & analogue
- 💧 Used to pinpoint exact leakage position prior to excavation



Trunk Mains Leakage Detection

- Localise
- Locate
- Pinpoint

- 💧 Trunk mains (transmission mains) often have:
 - Large diameters
 - Low pressure
 - Inhomogeneous pipe wall material (reinforced concrete)
 - Few access points
 - Long in distance
- 💧 All these make normal acoustic leakage detection difficult and other techniques have been developed
- 💧 These techniques are highly specialised and normally done by contractors

Equipment to buy

- Localise
- Locate
- Pinpoint

💧 **1st level** – getting started

- Listening stick
- Ground microphone

💧 **2nd level** – active leakage control

- Mid range correlator
- Noise loggers

💧 **3rd level** – advanced leakage control

- Tri correlator, multi function correlator
- Correlating Noise loggers

- Localise
- Locate
- Pinpoint

What should I buy ?

Factors affecting decisions

- 💧 LLP (Localise - Locate - Pinpoint)
- 💧 Noise loggers - Correlator - listening sticks
- 💧 Metallic - Plastic mains
- 💧 Rural - Urban region
- 💧 City - Town
- 💧 DMA's or No method of targeting
- 💧 Asset condition-numerous leaks ?
- 💧 Finance available
- 💧 Resources available
- 💧 Staff experience

What should I buy ?

Factors affecting decisions

- Localise
- Locate
- Pinpoint

- 💧 **LLP (Localise - Locate - Pinpoint)**
- 💧 **Noise loggers - correlator - listening stick**
- 💧 **Targeting areas = success**
- 💧 **If you choose the correct equipment for your infrastructure then you can purchase the cheaper option.**
- 💧 **Metallic mains, good pressure - all correlators will work**
- 💧 **Don't buy the Rolls Royce of equipment if it is not needed.**